Olfactory Cognitive Enrichment Training for a Male Asian Elephant

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Introduction

There are mixed views in the literature on the merits of cognitive enrichment training projects for elephants. Some reviews on 'controlled experiments' on elephant cognition argue that while these experiments have not supported widespread positive human understandings of elephant intelligence (Nissani 2008; Plotnik *et al*. 2009), this may be because new ways of investigating elephant cognition need to be found. Some authors argue that researchers have only made a small start in investigating elephant cognition in appropriate ways (Bates *et al*. 2008). They also argue that there has been a bias in past research on animal cognition, that has viewed those animals able to perform similar tasks (e.g. such as tool-making) to humans, as more intelligent (Bates *et al*. 2008) than animals with different kinds of 'higher order brain functions' (Hart *et al*. 2008).

This paper describes a behavioural enrichment project conducted with a male Asian elephant (*Elephas maximus*) at Perth Zoo, Australia. This project aimed to provide increased opportunity within enrichment training projects for the utilization of elephants' natural sensory and cognitive abilities. The World Association for Zoos and Aquariums notes that "enrichment projects in zoos and aquariums need to provide species-appropriate challenges, opportunities and stimulation for animals in human care" (Mellor *et al*. 2015).

This project utilizes the elephant's olfactory abilities to provide cognitive stimulation and problem solving situations as well as increased opportunities for physical exercise and investigation of the elephant's environment. This paper provides detailed description of the project in order to share this information and to provide assistance for others in trialling this form of behavioural enrichment.

Recent research suggests that elephants have twice as many olfactory receptor genes as dogs and five times that of humans (Niimura *et al*. 2014). As these authors note, olfaction is essential for the survival of most mammals, and is used for 'finding food, avoiding dangers, identifying mates and offspring, and identifying marked territory'. When olfactory receptor genes were classified and compared between 13 placental mammal species including African elephants (*Loxodonta africana*), the elephants were found to have the largest repertoire yet reported. It was suggested that this might be attributed to elephants' reliance on olfaction in contexts such as 'foraging, social communication and reproduction' (Niimura *et al*. 2014).

These findings correspond with neuro-anatomical studies on elephants having 'well-developed olfactory systems that include large olfactory bulbs and large olfactory areas in the brain'. In addition, research testing whether African elephants can detect the explosive TNT using olfaction, suggests that their 'well-developed cognitive processes … and memory retention … often act to support this ability' (Miller *et al*. 2015; Steyn 2015).

Other studies with Asian elephants have assessed their olfactory ability to distinguish between different odours (Arvidsson *et al*. 2012; Rizanovic *et al*. 2013). Research conducted at the Kolmarden Wildlife Park in Sweden demonstrated that Asian elephants could successfully be trained to cooperate in olfactory discrimination tests, and that they were capable of distinguishing between structurally related

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odour stimuli (Arvidsson *et al*. 2012). The authors noted that the results provide support for smell playing an 'important role in regulating the behaviour of Asian elephants' (Rizanovic *et al*. 2013). In addition, earlier studies suggest that African elephants may be able to distinguish between different local human ethnic groups, and can also possibly recognize 'up to 30 individual elephant family members from olfactory cues in mixtures of urine and earth' (Bates *et al*. 2008 quoted in Niimura *et al*. 2014).

The importance of olfaction in the lives of elephants in natural environments and the olfactory abilities identified in the above studies provide a solid basis for environmental and behavioural enrichment projects using olfactory cues for elephants in human care. The following project was developed with this in mind.

Materials and methods

Details of the elephant

The male Asian elephant Putra Mas is 28 years of age (Fig. 1). He was born in the wild in approximately 1989 and came to Perth Zoo from Malaysia with two female elephants of similar age in 1992. He was originally housed with the female elephants and handled in free contact until 1999. He was then moved to an adjacent enclosure in open protected contact when he reached sexual maturity. The olfactory training project was commenced with Putra Mas in 2014.

Details of the keeper

The Technical Officer Zoology (who is referred to in this paper as the 'keeper') is female and has worked at Perth Zoo in the elephant section for eight years. Previously, her work has been with marine mammals for 19 years, and she has been involved in behavioural enrichment training projects and observation research projects.

Description of training stages

Initially, the elephant Putra Mas was familiar with, and understood the retrieval concept. Thus the described enrichment behaviour originated as an extension of this already established retrieval behaviour.

The keeper began the project in 2014, and it has evolved through a number of stages. Firstly, the project involved the elephant searching for and finding objects with the aid of visual and audible prompts, and then later without those prompts. Then different scents were introduced with verbal cues, and the project evolved to the elephant searching for and finding these varied scents. Initially, the scents were placed closer to the elephant's location, and then the project was extended to involve larger search areas. Further work on the project can continue the extension of the opportunities and challenges of identifying, discriminating, searching and finding scents. Training was undertaken with the aim that Putra Mas would be able to indicate vocally when he had searched for and found a requested scent.

The first training session aimed at pairing his smelling of a vanilla scent with his 'hello' vocalization, which is a chirp sound. Repetitions were done using a vanilla scented tea strainer while the trainer asked him to do the 'hello' vocalization. This pairing training was conducted at the elephant barn drinker window.

Initially, Putra Mas was not providing the vocalization in association with the scent. The trainer allowed time to give him the opportunity to anticipate the association. When he did offer a 'hello' vocal after being presented with the scent,

Figure 1. Elephant "Putra Mas" at Perth Zoo.

this was then food reinforced with hay. Following repetitions, Putra Mas then began offering a vocalization when the scent was presented. It was then necessary for the trainer to quickly separate the 'smell' behaviour and 'find scent' behaviour indicators in order for Putra Mas to only indicate vocally when he had been searching for the scent and had found it, rather than on first smelling the scent. When Putra Mas gave a perfect response in the barn he was given hay. He picked up the pairing quickly.

By December 2016, if the scent was something that Putra Mas couldn't physically pick up and bring back to the trainer (e.g. liquid or a smear of paste), he vocalized to indicate the location of the scent straight away. If the scent was contained in an object that could be readily picked up, Putra Mas also vocalized, but not as consistently as when dealing with scents that could not be picked up.

Introduction of a variety of new smells

Different smells were trialled. As well as the already mentioned vanilla essence, other smells included Promite®, zebra faeces, echidna bedding, and the urine of two female Asian elephants at Perth Zoo. Also trialled were a lemongrass and ginger paste, perfume, human scented material and coffee grinds. Scents and foods that an elephant would find desirable to eat were not used.

The scents were initially placed on a material such as gauze. Later, other objects were used to hold the scented gauze. In one case, the gauze was placed in-between two circular interlocking plumbing discs made of wire mesh. Other objects used were a plastic fishing bait holder and strong poly-piping with a scented towel inside. For the coffee grinds, a tealeaf holder was initially used. Later, liquid coffee was poured onto the ground (Fig. 2). The urine scent was also poured direct onto sand. The elephant was very successful at finding this scent (Fig. 3). However, it was difficult to remove the scent.

The keeper found that when she used the stronger smelling scents, even when she removed the sand

Figure 2. Pouring liquid scent onto the ground.

from that area or covered it with fresh sand Putra Mas could still smell it there. So in later training sessions, even if he was searching for a different scent, he would naturally also go to the area with the lingering earlier scent. Learning from this, if using several scents in a training session, the keeper now begins with the weaker scents and works towards the stronger ones.

Discussion

This project was commenced in early 2014 and by late 2016 it had reached a stage where the elephant could successfully find a scent without visual or audible prompts. He had also learnt to give a vocal response upon identifying a scent. This project continues to provide the elephant with behavioural enrichment. The project has provided good physical exercise and mental stimulation in the process of the enrichment

Figure 3. Putra Mas searching the scent.

training, with the elephant responding well to the behavioural enrichment training.

The capacity for animals to be able to make choices within their environments has been a popular theme in recent discussions on the care and health of intelligent species. Challenges such as these deliver the ability for choice to Putra Mas, and therefore complement understandings of the 'Five Domains of Animal Welfare' in a fun, physical, and challenging program.

This project provided not only sensory and cognitive stimulation for this male elephant but presented him with problem solving challenges and encouraged investigation of the full extent of his enclosure. The level of success of this Asian elephant in performing tasks of odour-learning and long-term odour memory suggests that the sense of smell plays an important role in their behaviour. Behavioural and environmental enrichment projects that utilize these abilities can help to provide species-appropriate cognitive and physical opportunities for elephants in human care.

Conclusion

This enrichment training project has been successful in providing sense and mental stimulation as well as physical exercise for the elephant and in addressing needs as set out within the 'Five Domains of Animal Welfare' (Mellor & Beausoleil 2015). It follows pathways of natural sense and cognitive abilities of elephants in order to provide enhanced opportunities for Putra Mas to use and demonstrate these abilities.

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